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Ochiishi

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(54) **TRANSFER DEVICE SUCKING AND TRANSFERRING OBJECT**

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B25J 15/00	(2006.01)
B25J 9/16	(2006.01)
B65G 49/06	(2006.01)

(52) **U.S. Cl.**

CPC ***B25J 15/0616*** (2013.01); ***B25J 9/1612*** (2013.01); ***B25J 15/0052*** (2013.01); ***B65G 49/061*** (2013.01); *Y10S 901/40* (2013.01)

(58) **Field of Classification Search**

CPC .. B25J 15/0616; B25J 15/0052; B25J 9/1612; B65G 49/061; Y10S 901/40

See application file for complete search history.

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(57) **ABSTRACT**

A transfer device includes a suction unit capable of sucking an object and a transfer unit moving the suction unit. The suction unit includes a base member; a plurality of nozzles provided for a plurality of types of objects; a housing room formation unit attached to the base member, forming a housing room for housing the other end portion side of the plurality of nozzles, and including a sealing unit facing air outlets; a negative pressure generation unit generating negative pressure inside the housing room; and a drive unit driving the plurality of nozzles such that the air outlet of a nozzle selected from the plurality of nozzles in accordance with a type of the object is separated from the sealing unit, and the air outlet of a non-selected nozzle is bumped against the sealing unit to be sealed.

7 Claims, 6 Drawing Sheets

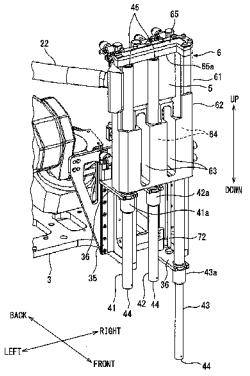


FIG. 1

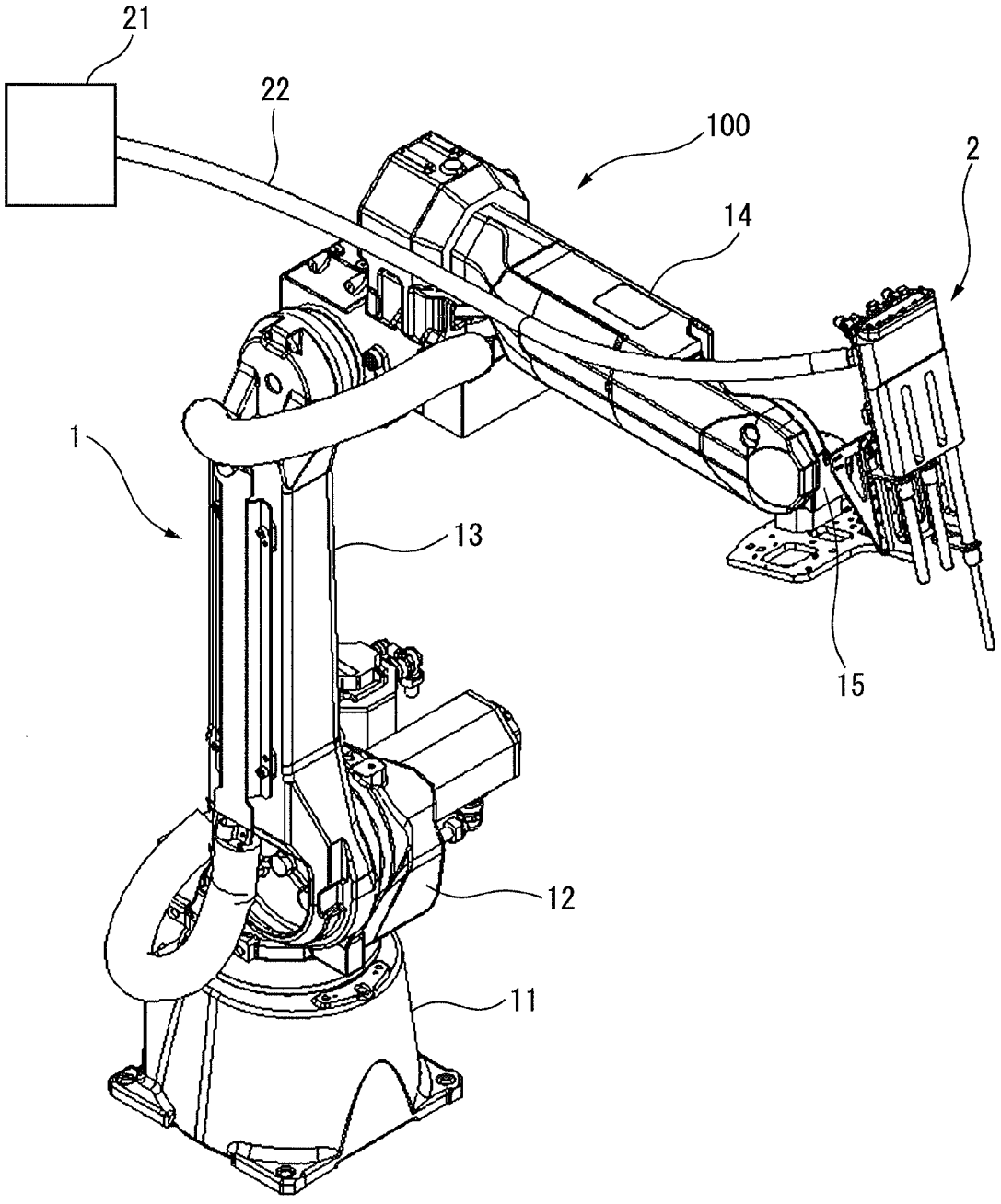


FIG. 2

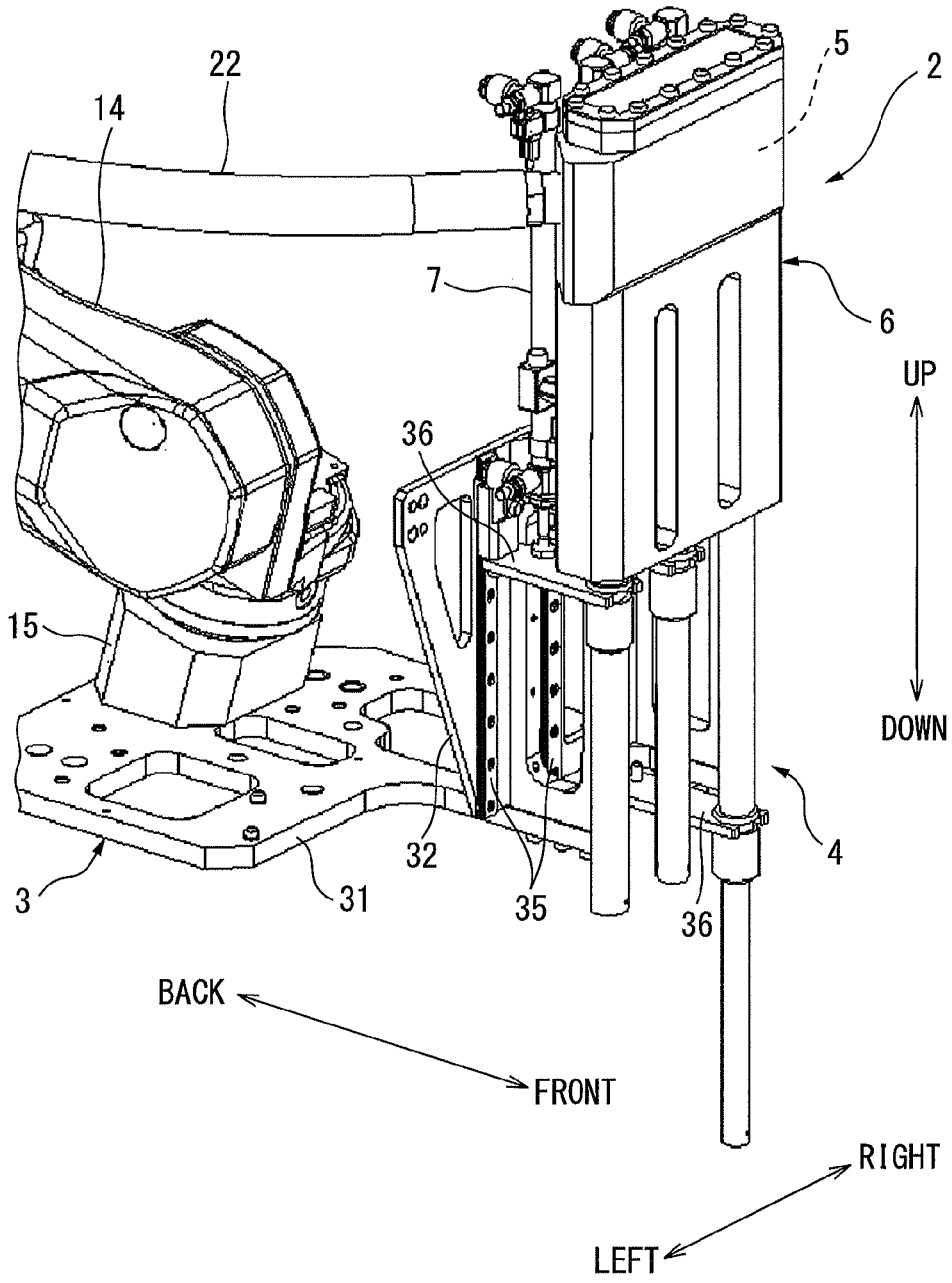


FIG. 3

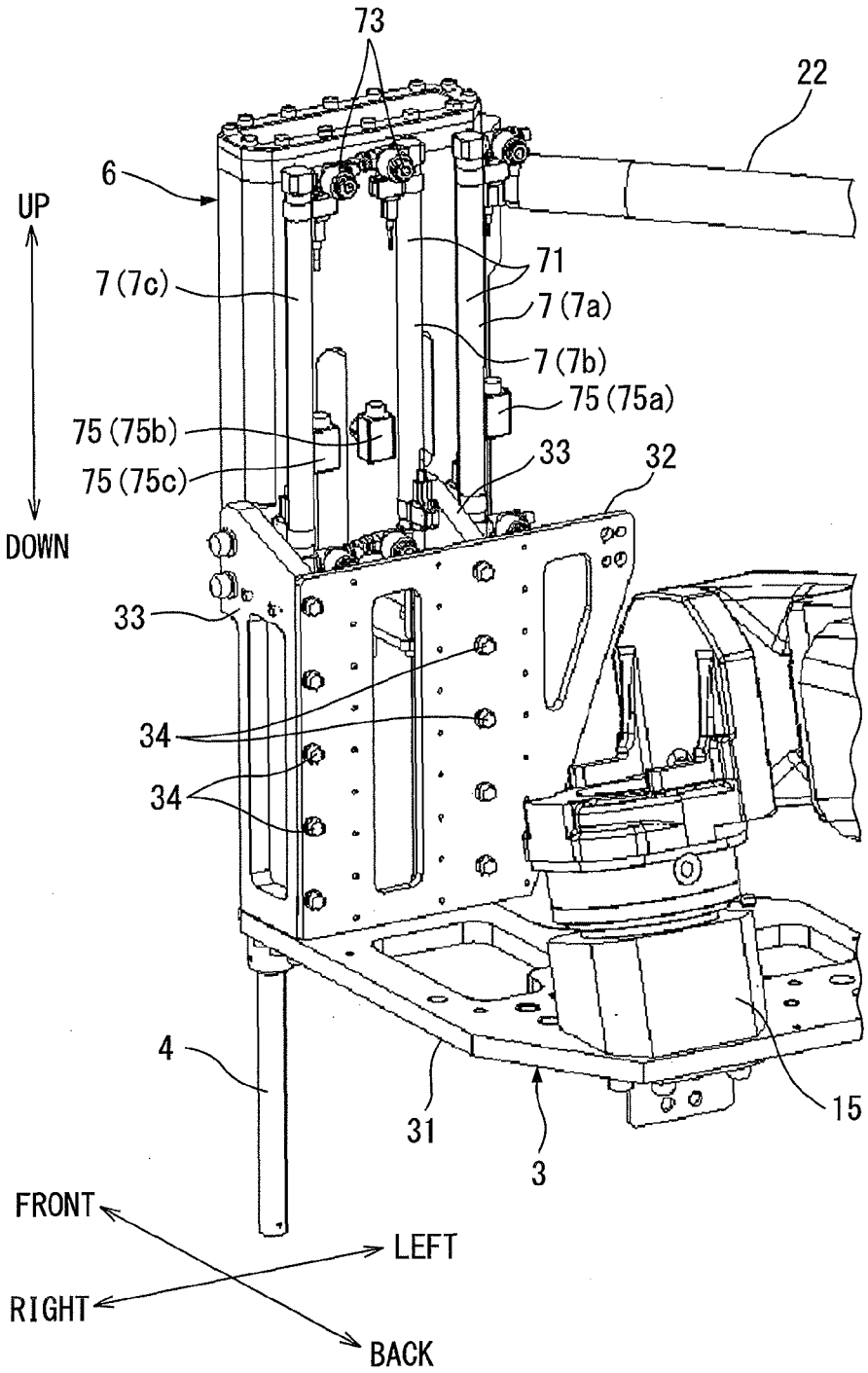

73
22
6
UP
7 (7c)
71
7 (7a)
7 (7b)
75 (75a)
75 (75b)
75 (75c)
33
32
DOWN
33
34
34
4
31
3
15
FRONT
LEFT
RIGHT
BACK

FIG. 4

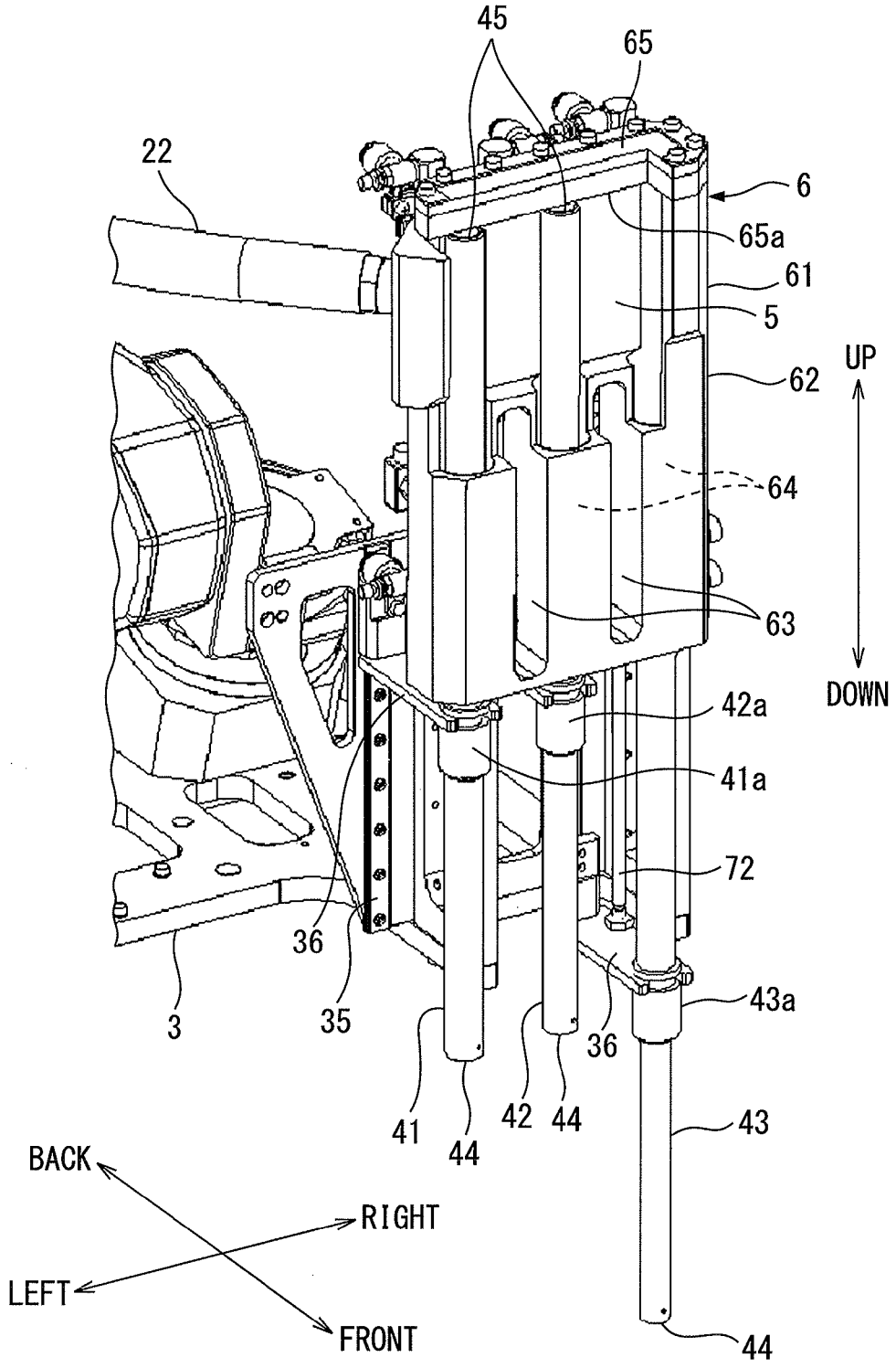

45
65
22
6
65a
61
5
UP
62
64
63
DOWN
42a
41a
72
36
3
35
43a
36
41
44
42
44
43
44
BACK
RIGHT
LEFT
FRONT

FIG. 5

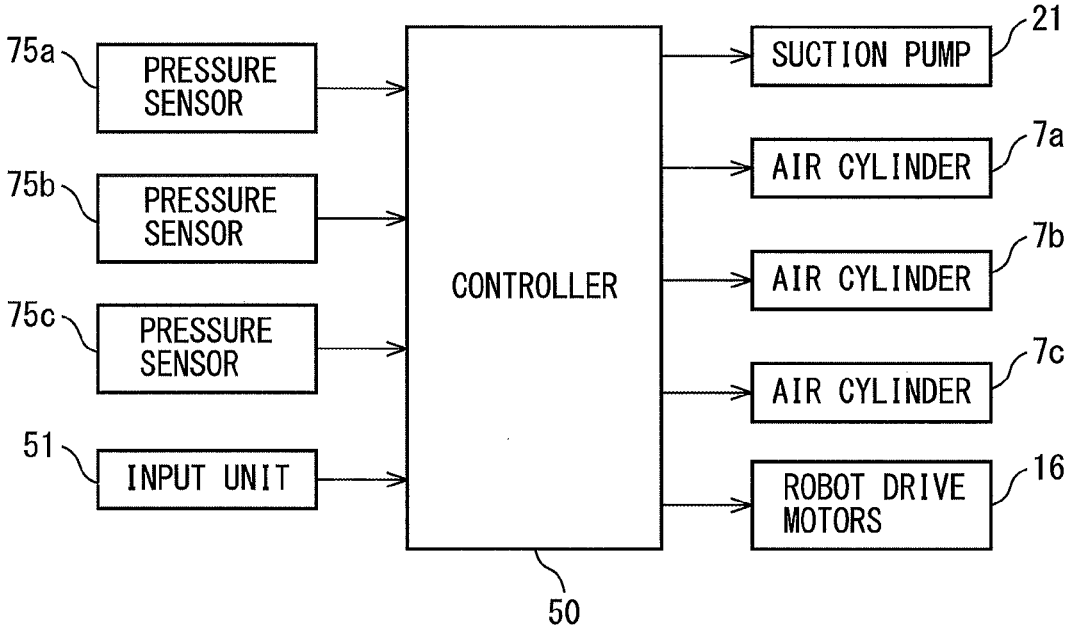

75a
PRESSURE SENSOR
75b
PRESSURE SENSOR
75c
PRESSURE SENSOR
51
INPUT UNIT
CONTROLLER
50
SUCTION PUMP
21
AIR CYLINDER
7a
AIR CYLINDER
7b
AIR CYLINDER
7c
ROBOT DRIVE MOTORS
16

FIG. 6

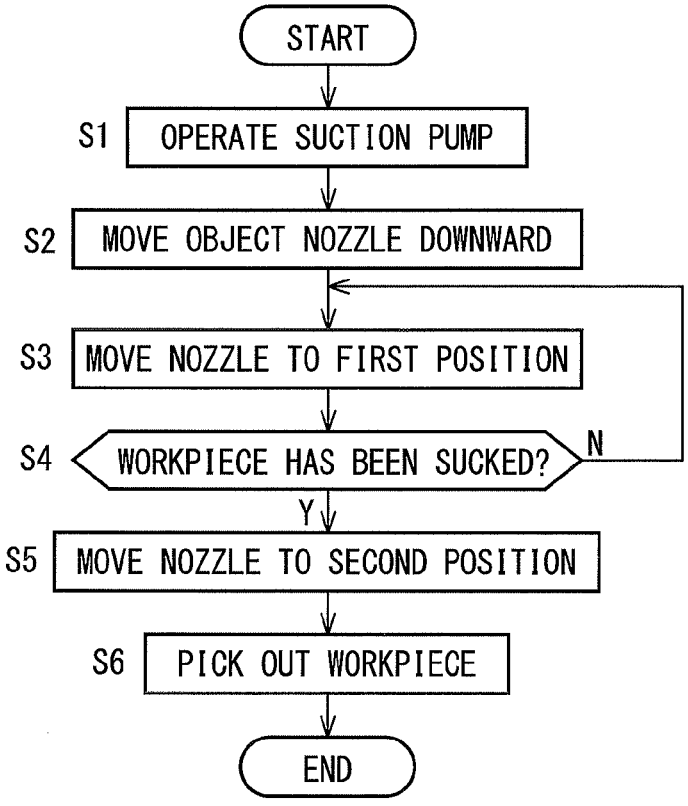
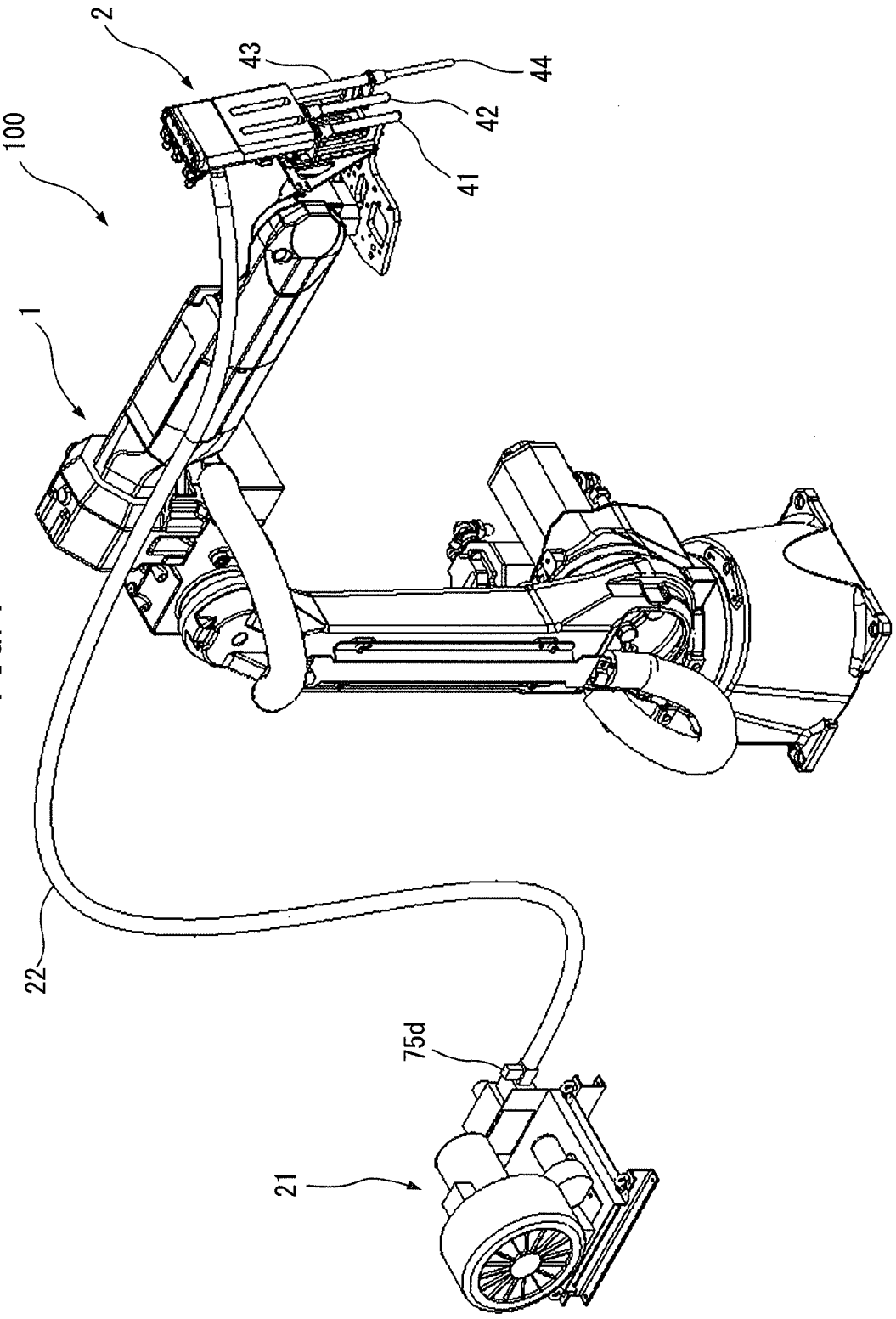

START
S1
OPERATE SUCTION PUMP
S2
MOVE OBJECT NOZZLE DOWNWARD
S3
MOVE NOZZLE TO FIRST POSITION
S4
WORKPIECE HAS BEEN SUCKED?
N
Y
S5
MOVE NOZZLE TO SECOND POSITION
S6
PICK OUT WORKPIECE
END

FIG. 7



TRANSFER DEVICE SUCKING AND TRANSFERRING OBJECT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a transfer device sucking and transferring an object.

2. Description of the Related Art

There is known a device that sucks an object such as a workpiece via a nozzle, and transfers the object. According to the device described in Japanese Laid-open Patent Publication No. 2012-240166 (JP 2012-240166 A), an object is sucked by using a single nozzle attached at a distal end portion of a robot. According to the device described in Japanese Laid-open Patent Publication No. 2011-243673 (JP 2011-243673 A), a nozzle is detachably mounted on a mounting head, and the nozzle adapted for a type of an object is used to suck the object.

However, in a configuration for using a single nozzle as in the device described in JP 2012-240166 A, it is difficult to suck various types of objects. In a configuration for replacing a nozzle in accordance with a type of an object as in the device described in JP 2011-243673 A, the configuration of the device is complicated, and in addition, working efficiency is reduced.

SUMMARY OF THE INVENTION

A transfer device according to one aspect of the invention includes a suction unit capable of sucking an object; and a transfer unit moving the suction unit, in which the suction unit comprises: a base member attached to the transfer unit; a plurality of nozzles provided for a plurality of types of objects, each of the nozzles including an air inlet at an end portion and an air outlet at another end portion; a housing room formation unit attached to the base member, forming a housing room for housing the other end portion side of the plurality of nozzles, and including a sealing unit facing the air outlets; a negative pressure generation unit generating negative pressure inside the housing room; and a drive unit driving the plurality of nozzles such that the air outlet of a nozzle selected from the plurality of nozzles in accordance with a type of the object is separated from the sealing unit, and the air outlet of a non-selected nozzle is bumped against the sealing unit to be sealed.

BRIEF DESCRIPTION OF THE DRAWINGS

The objectives, features, and advantages of the present invention will become further apparent from the following description of embodiments in conjunction with the accompanying drawings, in which:

FIG. **1** is a perspective view illustrating an entire configuration of a transfer device according to an embodiment of the present invention;

FIG. **2** is an enlarged perspective view of a suction device constituting the transfer device in FIG. **1**;

FIG. **3** is a further enlarged perspective view of the suction device constituting the transfer device in FIG. **1**;

FIG. **4** is a perspective view illustrating a state in which a part of a housing constituting the suction device in FIG. **2** is cut out;

FIG. **5** is a block diagram illustrating a control configuration of the transfer device according to the embodiment of the present invention;

FIG. **6** is a flowchart illustrating an example of processes performed by a controller in FIG. **5**; and

FIG. **7** is a perspective view of a transfer device according to a modified example of FIG. **1**.

DETAILED DESCRIPTION

Embodiments of the present invention will be explained below with reference to FIG. **1** to FIG. **7**. FIG. **1** is a perspective view illustrating an entire configuration of a transfer device **100** according to an embodiment of the present invention. The transfer device **100** includes an industrial robot **1** and a suction device **2**.

The robot **1** includes a base **11**, a turn unit **12** provided turnably on the upper side of the base **11**, a lower arm **13** supported rotatably at the turn unit **12**, an upper arm **14** supported rotatably at a distal end portion of the lower arm **13**, and a hand unit **15** supported rotatably at a distal end portion of the upper arm **14**. The suction device **2** is provided at a distal end portion of the hand unit **15**. The turn unit **12**, the lower arm **13**, the upper arm **14**, and the hand unit **15** are driven by servomotors (robot drive motors **16** in FIG. **5**), respectively so that the turn unit **12** is rotated relative to the base **11**, the lower arm **13** is rotated relative to the turn unit **12**, the upper arm **14** is rotated relative to the lower arm **13**, and the hand unit **15** is rotated relative to the upper arm **14**. Accordingly, the suction device **2** can move in a three-dimensional space by operation of the robot **1**, and a posture of the suction device **2** can be changed.

FIG. **2** is an enlarged perspective view of the suction device **2** in FIG. **1**. FIG. **3** is an enlarged perspective view of the suction device **2** seen from a direction different from that of FIG. **2**. For convenience, a front-back direction, a right-left direction, and an up-down direction are defined by the illustration in the drawings. In accordance with this definition, a configuration of the suction device **2** is described in the following. FIG. **2** illustrates the suction device **2** seen from an obliquely forward side, and FIG. **3** illustrates the suction device **2** seen from an obliquely backward side.

As illustrated in FIG. **2** and FIG. **3**, the suction device **2** includes a base member **3** attached to the distal end portion of the hand unit **15**, a plurality of (in the drawing, three) nozzles **4** provided on the front side of the base member **3** such that the nozzles **4** can ascend and descend (move in the up-down direction), a housing **6** attached to the base member **3** and forming a housing room **5** that houses upper portions of a plurality of the nozzles **4**, a suction hose **22** including an end portion connected to the housing room **5** and another end portion connected to a suction pump **21** (FIG. **1**), and a plurality of (three) air cylinders **7** moving a plurality of the nozzles **4** individually upward and downward.

The base member **3** is fixed to the hand unit **15**, and includes a flat plate unit **31** extending in the front-back direction and in the right-left direction, and a flat plate unit **32** rising upward from a front end portion of the flat plate unit **31**. On a front surface of the flat plate unit **32**, a pair of right and left side plates **33** extending in the up-down direction is fixed by bolts **34**, and supports the housing **6**. On the front surface of the flat plate unit **32**, a plurality of (three) guides **35** in the right-left direction are provided corresponding to the respective nozzles **4** and extend in the up-down direction, and holding plates **36** are respectively supported so as to ascend and descend along the respective guides **35**.

FIG. **4** is a perspective view illustrating a state in which a part of the housing **6** in FIG. **2** is cut out. A plurality of nozzles **4** are approximately cylindrical in shape, and have diameters different from each other so as to be adapted for types of

objects. In FIG. **4**, when the left, center, and right nozzles **4** are represented by the numerical symbols **41**, **42**, and **43**, a diameter of the nozzle **41** is the largest, and a diameter of the nozzle **43** is the smallest. Lengths of the nozzles **41** to **43** in the up-down direction are equal to each other. The nozzles **41** to **43** each include an air inlet **44** at a lower end thereof, and an air outlet **45** at an upper end thereof. At centers of the nozzles **41** to **43** in the up-down direction, held units **41***a* to **43***a* held by the holding plates **36** are provided. Ascending and descending operation of the holding plates **36** moves the nozzles **41** to **43** upward and downward.

The housing **6** is roughly classified into an upper housing unit **61** and a lower housing unit **62** of which boundary is a center of the housing **6** in the up-down direction. The upper housing unit **61** forms the single box-shaped housing room **5** over an entire range of the housing **6** in the right-left direction. In the lower housing unit **62**, elongate holes **63** penetrating the lower housing unit **62** in the front-back direction are provided at two right and left positions. The lower housing unit **62** is divided into three units in the right-left direction of which boundaries are the elongate holes **63**. At the divided respective lower housing units **62**, penetration holes **64** are respectively provided to be opened in the up-down direction. The housing room **5** in the upper housing unit **61** is branched into the three penetration holes **64**. The nozzles **41** to **43** are respectively inserted into the respective penetration holes **64** so as to be slidable. Between each outer circumferential surface of the nozzles **41** to **43** and each inner circumferential surface of the penetration holes **64**, seal units not illustrated are provided to secure the seal of the housing room **5**.

As illustrated in FIG. **3** and FIG. **4**, a plurality of air cylinders **7** (**7***a* to **7***c*) provided for the nozzles **41** to **43** are arranged between the flat plate unit **32** of the base member **3** and the housing **6**, and extend in the up-down direction. Each of the air cylinders **7** includes a cylinder unit **71** fixed to the base member **3** (the flat plate unit **32** and the side plate **33**), and a rod unit **72** slidably inserted into the cylinder unit **71**. The holding plate **36** is fixed to a lower end portion of the rod unit **72**. At an upper end portion of the cylinder unit **71**, an air supply unit **73** is provided to which, a compressed air is supplied via a hose not illustrated. Supply of the compressed air from the air supply unit **73** to the cylinder unit **71** is controlled to expand and contract the air cylinder **7**. Thereby, the holding plate **36** moves upward and downward integrally with the nozzle **4**.

In FIG. **4**, the nozzles **41** and **42** are moved upward to the upper limit position. This state is referred to as a housed state. In the housed state, upper end portions of the nozzles **41** and **42** are pressed against an inner wall face **65***a* of an upper wall **65** of the housing **6**, and the air outlets **45** are closed. At this time, portions of the nozzles **41** and **42** that are positioned below the held units **41***a* and **42***a* protrude from the housing **6**. Meanwhile, in FIG. **4**, the nozzle **43** is moved downward to the lowest position. This state is referred to as a used state. In the used state, an upper end portion of the nozzle **43** is separated from the inner wall face **65***a*, and is at an intermediate position in the penetration hole **64**, and the air outlet **45** faces the housing room **5**, and is opened. At this time, the nozzle **43** protrudes downward more than the other nozzles **41** and **42**. In each case of the used state and the housed state, the air inlet **44** faces the atmosphere.

As illustrated in FIG. **3**, a plurality of (three) pressure sensors **75** (**75***a* to **75***c*) for the nozzles **41** to **43** are attached to a backward face of the housing **6**. The respective pressure sensors **75** communicate with the three penetration holes **64** of the lower housing unit **62**, more specifically, spaces above the air outlets **45** of the nozzles **4** in the used state. When an object is sucked to the lower end portion of the nozzle **4**, the air inlet **44** is closed, and flow of air in the nozzle **4** is stopped. At this time, a detection value of the pressure sensor **75** changes. On the basis of the change in the detection value of the pressure sensor **75**, it can be determined whether or not an object has been sucked.

FIG. **5** is a block diagram illustrating a control configuration of the transfer device **100** according to the present embodiment. The controller **50** is configured so as to include an arithmetic processing unit including a CPU, a ROM, a RAM, additional peripheral circuits, and the like. An input unit **51** and the pressure sensors **75***a* to **75***c* are connected to the controller **50**. The input unit **51** inputs a command for starting to transfer an object, a type of an object, and the like. On the basis of signals from the input unit **51** and the pressure sensors **75***a* to **75***c*, the controller **50** performs predetermined processes to output control signals to the suction pump **21**, the air cylinders **7***a* to **7***c*, and the robot drive motors **16**.

FIG. **6** is a flowchart illustrating one example of the processes at the controller **50** at the time of object transfer operation. In the object transfer operation, a designated workpiece is taken out from workpieces as objects heaped at a first position, and the taken-out workpiece is then transferred to a second position. The flowchart is started by, for example, inputting a type (a shape, a size, and the like) of a workpiece by operating the input unit **51**, and then inputting a transfer start command. Before a transfer start command is input, all of the nozzles **41** to **43** are moved to be in the housed state. Instead of inputting a type of a workpiece by the input unit **51**, identification of the nozzle **41**, **42** or **43** to be used may be input.

At the step S**1**, a control signal is output to the suction pump **21** to cause the suction pump **21** to operate. At this time, air does not flow in the nozzles **41** to **43** since the air outlets **45** of the nozzles **41** to **43** contact with the inner wall face **65***a* of the upper wall **65** of the housing **6**.

At the step S**2**, the nozzle **4** adapted for the type of a workpiece input by the input unit **51** is selected as an object nozzle. For example, when the workpiece is large, the nozzle **41** having the large diameter is selected, and when the workpiece is small, the nozzle **43** having the small diameter is selected. On the assumption that the nozzle **43** is selected, and the nozzles **41** and **42** are not selected, description is made in the following.

Further, at the step S**2**, a control signal is output to the air cylinder **7***c* corresponding to the selected object nozzle **43** to move the air cylinder **7***c* downward. Accordingly, the object nozzle **43** is moved downward as illustrated in FIG. **4**, and the air outlet **45** is opened. In other words, the object nozzle **43** is set in the used state. As a result, air flows in the object nozzle **43** through the air inlet **44**, and negative pressure is generated in the housing room **5**. Thereby, suction of a workpiece by the object nozzle **43** is enabled. In this case, the other nozzles **41** and **42** are left in the housed state. Accordingly, air does not flow in the other nozzles **41** and **42**, and the other nozzles **41** and **42** can be prevented from sucking the workpiece.

At the step S**3**, a control signal is output to corresponding robot drive motor **16** to move the object nozzle **43** toward the first position.

At the step S**4**, on the basis of detection values from the pressure sensors **75***a* to **75***c*, it is determined whether or not the object nozzle **43** has contacted with a workpiece. Specifically, when the lower end portion of the object nozzle **43** contacts with a workpiece in a state in which the object nozzle **43** has moved downward, the workpiece is sucked to close the air inlet **44**, and a detection value of the pressure sensor **75***c* changes. Accordingly, at the step S**4**, by determining whether

or not a detection value of the pressure sensor **75***c* changes beyond a predetermined threshold, it is determined whether or not the object nozzle **43** has contacted with a workpiece. When a positive decision at the step **S4** is made, the procedure advances to the step **S5**. When a negative decision at the step **S4** is made, the procedure returns to the step **S3**.

At the step **S5**, a control signal is output to corresponding robot drive motor **16** to move the object nozzle **43** toward the second position while maintaining the object nozzle **43** in the used state, i.e., keeping the object nozzle **43** protruded more than the other nozzles **41** and **42**.

At the step **S6**, operation of the suction pump **21** is stopped in a state where the object nozzle **43** has arrived at the second position. Thereby, the workpiece is removed (is taken to be placed) from the object nozzle **43**. Thus, the workpiece is transferred to the second position.

According to the present embodiment, the following advantageous effects can be obtained.

(1) The suction device **2** includes the base member **3** attached to the robot **1**; a plurality of the nozzles **41** to **43** provided for a plurality of types of objects; the housing **6** attached to the base member **3**, the housing **6** forming the housing room **5** which houses the parts included in a plurality of the nozzles **41** to **43** and positioned on the side of the air outlets **45**, the housing **6** including the inner wall face **65***a* facing the air outlets **45**; the suction pump **21** generating negative pressure inside the housing room **5**; and the air cylinders **7** driving a plurality of the nozzles **41** to **43** such that the air outlet **45** of the nozzle **43** selected from a plurality of the nozzles **41** to **43** in accordance with the type of an object is separated from the inner wall face **65***a*, and the air outlets **45** of non-selected nozzles **41** and **42** are bumped against the inner wall face **65***a* to be sealed.

Accordingly, it is not necessary to change the nozzles **4** in accordance with a type of an object, and with a simple configuration, operation of transferring a plurality of types of objects can be performed efficiently. Further, in a device including a plurality of the nozzles **7**, it is not necessary to provide electromagnetic valves for switching, from each other, suction lines extending to the respective nozzles **7**, and the transfer device **100** can be configured easily and at low cost. In other words, when a plurality of nozzles are simply attached to a robot, and a suction pump is connected to the respective nozzles via electromagnetic valves, an suction hose and the electromagnetic valve are necessary for each nozzle. In this case, since a plurality of the suction hoses are needed, it is difficult to stretch and arrange the suction hoses. In addition, when the electromagnetic valves are installed at a distal end portion of the robot, a weight at the distal end portion of the robot increases, and accordingly, for this weight, a robot capable of transferring a heavy object is demanded. In this regard, in the present embodiment, electromagnetic valves for switching suction lines from each other do not need to be used. For this reason, increase in a weight at a distal end portion of the robot can be prevented, and the suction hose **22** can be easily stretched and arranged.

(2) The suction device **2** is attached to the general-purpose robot **1**. For this reason, it is possible to easily pick out and place an object over a wide range.

(3) The air cylinders **7** move the nozzles **4** to set the nozzles **4** in the used state or the housed state. For this reason, when the nozzle **4** is moved to the first position, and a distal end of the nozzle is thereby pressed against an object, the air cylinder **7** expands and contracts so that damage to the object can be reduced.

(4) The pressure sensors **75***a* to **75***c* are provided for the nozzles **41** to **43**, respectively. On the basis of detection values of the pressure sensors **75***a* to **75***c*, it is determined whether or not an object has been sucked. For this reason, transferring an object can be securely carried out with the object being sucked.

Although, in the above-described embodiment, the pressure sensors **75***a*, **75***b*, and **75***c* are provided for the nozzles **41** to **43**, respectively, a pressure sensor **75** as a pressure detector may be provided at a different position. FIG. **7** is a perspective view of a transfer device **100** according to a modified example of FIG. **1**. In FIG. **7**, a pressure sensor **75***d* is provided at the suction hose **22** connecting the suction device **2** and the suction pump **21** to each other. In this case, when a workpiece is sucked to the lower end portion of the object nozzle **43**, the air inlet **44** is closed, which causes a change air flow in the suction hose **22**. This enables the controller **50** as a determination unit to determine whether or not the workpiece has been sucked. With the configuration of FIG. **7**, the number of the pressure sensors **75** can be reduced, and the transfer device **100** can be configured at lower cost.

In the above-described embodiment, the suction device **2** as a suction unit is transferred by the robot **1**. However, a device other than the robot **1** may be used as a transfer unit. In the above-described embodiment, a single nozzle (for example, the nozzle **43**) selected from a plurality of the nozzles **41** to **43** in accordance with a type of an object is set in the used state, and non-selected nozzles (for example, the nozzles **41** and **42**) are set in the housed state. However, a plurality of the nozzles may be selected to be set in the used state. In the above, a plurality of the nozzles **41** to **43**, each of which has the same lengths, have the different diameters from each other. However, as long as the nozzles have the air inlets **44** and the air outlets **45**, the nozzles may have lengths different from each other and shapes different from each other. In the above, in the housed states, the air outlet **45** of the nozzle **4** is made to contact with the inner wall face **65***a* of the housing **6**. However, as long as air flow in the nozzle **4** is stopped, a constituent element other than the inner wall face **65***a* may be used as a sealing unit. In the above-described embodiment, the air cylinders **7** drive a plurality of the nozzles **4**. However, a configuration of a drive unit is not limit to this.

In the above-described embodiment, the suction pump **21** is connected to the suction device **2** via the suction hose **22** to generate negative pressure inside the housing room **5**. However, a configuration of a negative pressure generation unit is not limited thereto. In the above-described embodiment, the housing **6** forms the housing room **5**. However, as long as a housing room formation unit is attached to the base member **3**, forms the housing room **5**, and includes the sealing unit facing the air outlet **45**, a configuration of the housing room formation unit is arbitrary.

The above-described embodiment can be combined arbitrarily with one or a plurality of the modified examples.

According to the present invention, the air outlet of the nozzle selected in accordance with a type of an object is separated from the sealing unit, and the air outlet of non-selected nozzle is bumped against the sealing unit to be sealed. Accordingly, with a simple device configuration, operation of transferring various types of objects can be efficiently performed.

In the above, the present invention is described with reference to the preferred embodiment of the present invention. However, it would be understood by a person skilled in the art that various modifications and alterations can be made without departing from the disclosure range in the claims described later.

The invention claimed is:

1. A transfer device comprising:

a suction unit capable of sucking an object; and

a transfer unit moving the suction unit, wherein the suction unit comprises:

a base member attached to the transfer unit;

a plurality of nozzles provided for a plurality of types of objects, each of the nozzles including an air inlet at an end portion and an air outlet at another end portion;

a housing chamber formation unit attached to the base member, forming a chamber for housing said another end portion of each of the plurality of nozzles, and including a sealing unit located at an end of said chamber and facing the air outlets of the plurality of nozzles;

a negative pressure generation unit generating negative pressure inside the chamber; and

a drive unit driving the plurality of nozzles such that the air outlet of a nozzle selected from the plurality of nozzles in accordance with a type of the object is separated from the sealing unit, and the air outlet of a non-selected nozzle is positioned against the sealing unit to be sealed.

2. The transfer device according to claim **1**, wherein the transfer unit is a robot.

3. The transfer device according to claim **1**, wherein the drive unit is constituted by air cylinders.

4. The transfer device according to claim **1**, further comprising: a plurality of pressure detectors respectively attached to the plurality of nozzles to detect inside pressure of respective nozzles; and a determination unit determining whether or not the object has been sucked, for each of the plurality of nozzles, on the basis of detection values of the pressure detectors.

5. The transfer device according to claim **1**, wherein the negative pressure generation unit includes a suction pump, and a suction hose of which an end portion is connected to the chamber and of which another end portion is connected to the suction pump, and the transfer device further comprises: a pressure detector attached to the suction hose to detect inside pressure of the suction hose; and a determination unit determining whether or not the object has been sucked, on the basis of a detection value of the pressure detector.

6. The transfer device according to claim **1**, wherein the sealing unit is a single flat planar surface defined at said end of the chamber.

7. The transfer device according to claim **1**, wherein each nozzle comprises a hollow cylinder and the air inlet and the air outlet of the nozzle are positioned at opposite ends of the hollow cylinder.

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